

Supergravity Inflation Free from Harmful Relics

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Outline

1. SUGRA inflation model building

- inflaton potential
(careful choice of W & K)
- moduli problem
- gravitino problem

2. Specific model free from above problems

3. Conclusion & Discussion

SUGRA inflation model

- Model to be discussed

$$W = \frac{\Box^2 (\Box \Box M_p)^2}{M_p} + \Box_1 (\Box \Box_2^2 \Box \Box^2) + \Box \Box_2 \Box_3 + C$$

$\Box \Box 1, \Box, \Box \Box 10^{10} GeV$ (intermediate scale)

$\Box \Box 10^{14}$ from COBE normalization

$C = \frac{\Box^2 M_p}{\sqrt{3}}$ for vanishing cosmological constant in the vacuum

Inflaton Sector

$$W_{\text{inf}} = \frac{(\Box \Box M)}{M},$$

$$V = e^{\Box^2/2} \left(1 + \frac{\Box^2}{2} + \sqrt{2}\Box^3 + \frac{7}{8}\Box^4 + \frac{\Box^5}{\sqrt{2}} + \frac{\Box^6}{8} \right).$$

\Box (scalar component of superchiral field \Box): inflaton field.

COBE norm $\Box \Box \Box 10^{-4}$.

$$m_\Box \Box \frac{\Box^2}{M_p} \Box 10^{28}$$

$$\Box_\Box \Box \frac{m_\Box^3}{M_p^2} \Box \text{ decay at } t \Box \frac{1}{\Box_\Box} \Box 10^{25} M_p \Box$$

Hidden Sector

$$W_{hidden} = \Box_1 (\Box_2^2 - \Box \Box^2) + \Box \Box_2 \Box_3 + C$$

Vanishing Cosmological Const $\Box C = \frac{\Box M_p}{\sqrt{3}},$

- $\Box_2, \Box_3 \approx 0$ during inflation and stay there via R-sym.
- massless \Box_1 has flat direction at tree level.

$\Box \Box \Box \Box$ (global) SUSY radiative correction $\Box \Box \Box \Box$

- $V_{\text{one loop}} \approx \frac{\Box^4 \Box^4 \Box_1^2}{8 \Box^2 \Box^2}$ for $|\Box| \ll \frac{\Box}{\Box}.$
- $K_{\text{correction}} = \frac{\Box^4 \Box_1^2 \Box_1^{+2}}{32 \Box^2 \Box^2}$
- massless $|\Box_1| \approx \Box \Box \Box \Box \Box \Box \Box \Box \Box m_{\Box}^2 = \frac{\Box^4 \Box^4}{8 \Box^2 \Box^2}$ (intermediate scale)
- $\Box_{\Box_1} \approx \frac{m_{\Box_1}^2}{|F|^2}$ decay at $t \approx \frac{1}{\Box_{\Box_1}} \approx 10^{13} M_p$

Harmful Relics

- Moduli problem

- Energy stored during the inflation

- overdilutes baryon asymmetry

- upsets nucleosynthesis via late decay

- No problem thanks to radiative correction which raises the mass of \Box_l to intermediate scale. (\Box_l decays much faster than inflaton well before nucleosynthesis.)

- Gravitino production from decay

- estimate for gravitino number density to entropy ratio for our model,

$$\frac{n_{3/2}}{s} < 3.5 \cdot 10^{14} \frac{T_{RH}}{10^{10} GeV}$$

- Smaller than constraint from gravitino production via thermal scattering,

$$\frac{n_{3/2}}{s}(\text{scattering}) < 1.8 \cdot 10^{12} \frac{T_{RH}}{10^{10} GeV} \quad (\text{kawasaki et al, hep-ph/0012279})$$

Non-thermal Production of Gravitino

- Possible efficient production of gravitino during the preheating era.
(the coupling to longitudinal component of gravitino is not Planck mass suppressed.)
- Calculation for gravitino number density via generalized Bogoliubov transformation (Nilles et al, hep - th/0103202).
(□ nontrivial mixing of fermion mass eigenstates.)
- Estimate for upper bound for our model,

$$\frac{n_{3/2}}{s} < 6.3 \cdot 10^{15} \cdot \left(\frac{T_{RH}}{10^{10} GeV} \right).$$

(smaller than thermal production constraint,

$$\frac{n_{3/2}}{s} (\text{scattering}) < 1.8 \cdot 10^{12} \frac{T_{RH}}{10^{10} GeV}.)$$

Conclusion & Discussion

- Realistic SUGRA inflation free from harmful relics
(gravitino problem, moduli problem, inflaton potential)
 - Careful choice of W & K
 - radiative correction \square non - minimal K
 - Non - thermal production of gravitinos
 \mapsto Is it 'dangerous' for other models as well?
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(c.f. ' Supergravity Inflation Free from Harmful Relics ' , P. Greene, H. Murayama, K.K. hep- ph/0208276) 8